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(71) Applicant(s)
Otter Controls Limited
(Incorporated in the United Kingdom)
Hardwick Square South, BUXTON, Derbyshire,
SK17 6LA, United Kingdom

(72) Inventor(s)
David Andrew Smith

(74) Agent and/or Address for Service
R.G.C. Jenkins & Co
26 Caxton Street, LONDON, SW1H 0RJ,
United Kingdom

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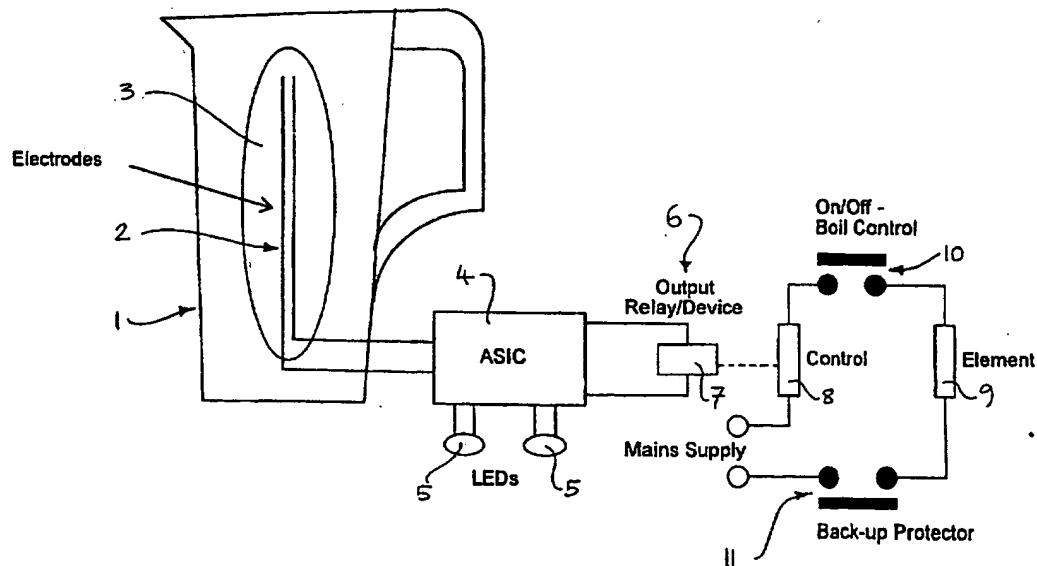
(56) Documents Cited
US 5756876 A US 5671113 A US 4544830 A

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INT CL⁷ **A47J 27/21, G01F 23/26**
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(54) Abstract Title

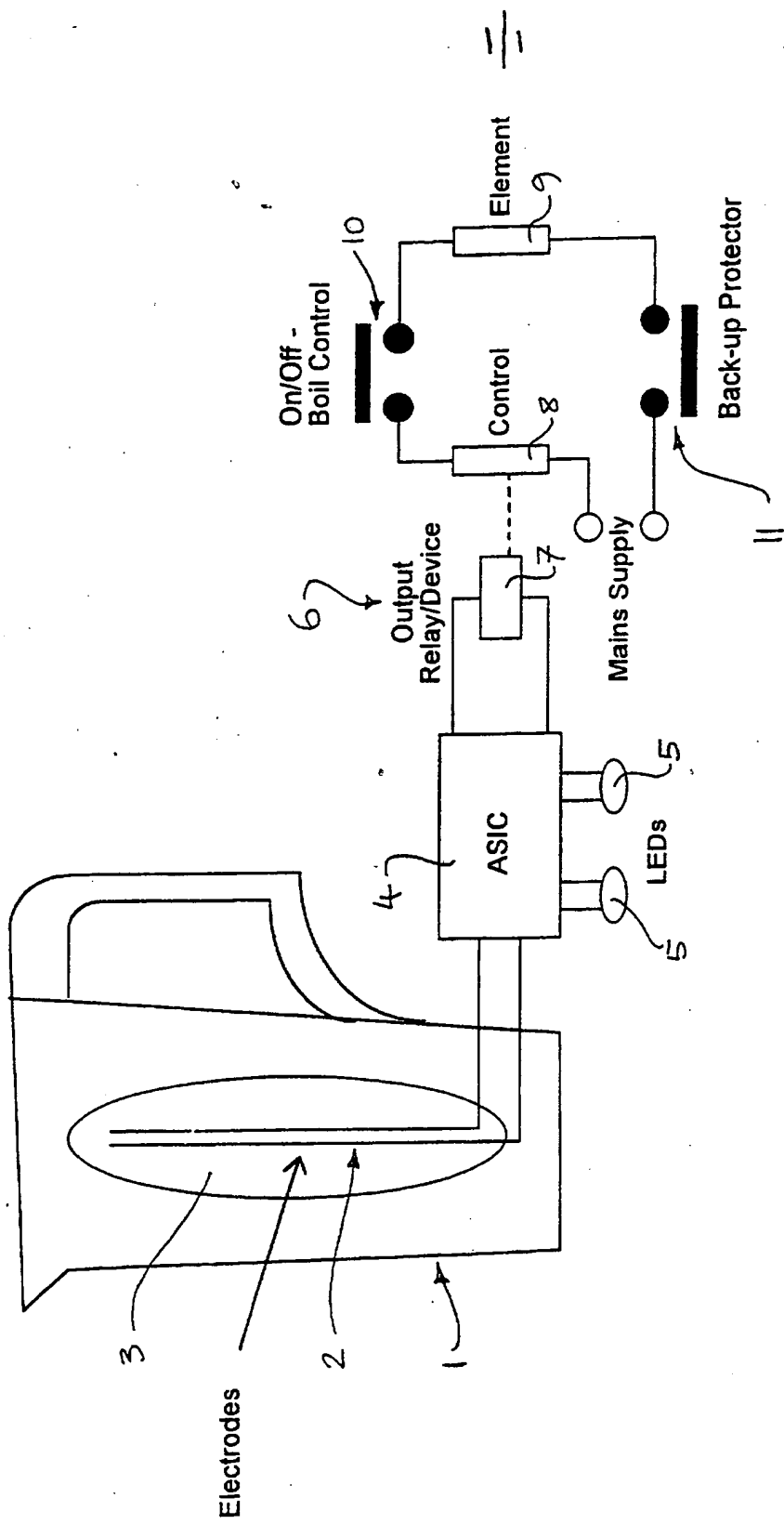
Liquid heating device with excessive or insufficient water level protection means.

(57) An electric liquid heating device such as a kettle or hot water jug 1 incorporates a capacitive liquid level sensor providing an output 6 to disable the supply of power to the heating element 9 in the event of there being excessive or insufficient water in the appliance. The liquid heating device 1 has a pair of parallel electrodes 2 constituting a capacitive sensor in a sight glass 3 provided in the jug wall. The electrodes 2 are connected to an integrated circuit control device 4 which, in response to the capacitance between the electrodes 2, is arranged to determine if the liquid in the jug is above a maximum level or below a minimum level and to illuminate a respective one of LEDs 5 in response thereto. In response to excessive or insufficient liquid in the jug 1, the control device 4 also activates an output device 6, shown as a relay coil 7 and associated switch 8. Switch 8, connected in the electrical supply path to the heating element 9 and in series with a boil control 10 and back-up protector 11, ensures that the element cannot be powered if the liquid level in the jug is excessive or insufficient.



Basic Control Circuit.

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Basic Control Circuit.

IMPROVEMENTS RELATING TO LIQUID**HEATING VESSELS****Field of the Invention:**

This invention concerns improvements relating to liquid heating
5 vessels and particularly concerns electric kettles and hot water jugs and the
like.

Background of the Invention:

Modern electric kettles and hot water jugs conventionally incorporate
10 controls for protecting the appliance against risk of overheating in the event of
the appliance being switched on empty or being allowed to boil dry, such dry
boil element protector controls commonly incorporating one or more
thermally sensitive actuators in the form of bimetallic and/or fusible members.
It is also common to provide a boil control in such an appliance for switching
15 off or reducing the power supply to the heating element in response to boiling
of the contents of the appliance, such boil controls commonly comprising a
bimetallic or SME (Shape memory effect) thermally-responsive actuator
which responds to the generation of hot steam when water boils in the
appliance. Examples of dry boil element protector controls are the X4
20 controls that we manufacture and which are substantially as described
in WO-A-9954903 and the U-Series controls that are manufactured by Strix

Limited and which are substantially as described in WO-A-9534187; the complication of these controls is self apparent.

Electronic controls for kettles and hot water jugs have also been proposed, for example in GB-A-2185161 but are not competitive with
5 electromechanical controls as abovementioned for the majority of applications.

Objects and Summary of the Invention:

The principal object of the present invention is to enable a
10 simplification of modern electromechanical controls such as those abovementioned.

According to the present invention, the need for dry boil protection in an electric kettle or hot water jug or the like is obviated by provision of a capacitive liquid level sensor arranged to disable the supply of electricity to
15 the appliance heating element if there is insufficient water in the appliance.

The invention thus contemplates, in an exemplary embodiment, the provision of a capacitive sensor in the body of a liquid heating appliance at a location appropriate to detection of an insufficient amount of liquid in the appliance, and control means responsive to the sensor for operating a switch
20 in the supply to the appliance heating element. The conventionally provided dry boil protector would be omitted, though a back-up protector preferably would be provided to ensure that the appliance was protected in the event of

failure of the capacitive sensor and/or its associated control. A boil control would be provided to switch off the appliance when its contents boiled. The advantage of this arrangement is that the provision of the capacitive sensor and its associated control means, which can be constituted by a simple and inexpensive electronic circuit, enables the dry boil control to be omitted since the appliance heating element cannot be powered if there is no or insufficient liquid in the appliance.

The capacitive level sensor could also be arranged to be responsive to overfilling of the appliance, which would be advantageous in that it would ensure that scalding liquid could not be splashed out of the appliance and/or into the boil control. Alternatively, this function could be performed by a separate capacitive liquid level sensor.

Capacitive liquid level sensors are well known per se and have been employed for the indication and monitoring of the levels of liquids and other materials in a variety of vessels. However, insofar as we are aware they have not been used in liquid heating appliances such as kettles and hot water jugs. A proposal has been made in GB 1 408 387 to protect a kettle by use of a float system which switches off the kettle element if there is insufficient water in the kettle. However, float systems are fundamentally ill suited to use in water boiling vessels on account of the build-up of lime scale and general corrosion within the vessel inhibiting the float operation.

The above and further features of the invention are set forth in the appended claims and will be well understood from consideration of the following description of an exemplary embodiment of the invention which is illustrated in the accompanying drawing.

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Description of the Drawing:

The single figure of the accompanying drawing is a schematic showing of an electrically heated hot water jug which is provided with an exemplary capacitive sensor according to the teachings of the present invention.

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Detailed Description of the Embodiment:

Referring to the drawing, a hot water jug 1 has a pair of parallel electrodes 2 constituting a capacitive sensor concealed by the markings (not shown) of a sight glass 3 provided in the jug wall. The electrodes 2 are connected to an integrated circuit control device 4 which, in response to the capacitance between the electrodes 2, is arranged to determine if the liquid level in the jug is above a maximum level or below a minimum level and to illuminate a respective one of LEDs 5 in response thereto. In response to detection of excessive or insufficient liquid in the jug 1, the control device 4 also actuates an output device 6 shown in the embodiment as a relay coil 7 and associated switch 8. The switch 8, as shown schematically in the drawing, is connected in the electrical supply path to the heating element 9 of

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the jug 1, in series with a boil control 10 and a back-up protector 11, and ensures that the element 9 cannot be powered if the liquid level in the jug 1 is too high or too low.

Clearly such a system is most suited for an electronically controlled
5 kettle, such as that proposed in GB-A-2185161 or as is now manufactured by Russell Hobbs Limited. This would limit the power output needed from ASIC 4, which would otherwise have to be able to drive a relay or other electromechanical device. The advantage of such a system is in reducing the cost and complexity of the required safety controls. If the kettle cannot be
10 switched on with no water in it then there is no need for a primary dry boil control. Some form of back-up safety control would, of course, still be required.

The mounting of the capacitive sensor will require some care to ensure that it is protected from damage and is able to detect the water within the
15 vessel. It will not work through a metal wall, for example. On a plastics material moulded jug the sensor could work satisfactorily if it was simply stuck on the outside, but this would look less than fashionable, so we propose sinking a sensor strip into a cavity in the vessel wall and fitting a simple decorative cover. The same cover could, if necessary, also cover the two
20 wires which lead from the sensor 2 to the control 4. The sensor 2 itself can comprise two thin wire electrodes, arranged as a parallel pair, bonded to a flexible film substrate approximately 200mm wide and as long as the height to

be sensed. The two sensor electrodes may be approximately 3mm apart. The electrodes 2 could be mounted on a transparent film substrate, and sandwiched between two transparent plastic mouldings making a sort of double glazed level gauge. This assembly could then be moulded into the jug body. Again, arrangements would have to be made to get the connecting wires back to the control. With such an arrangement the two thin electrodes 2 would be almost invisible, but could, in any case, be concealed by the markings of the level gauge. Alternatively one wall of the sight gauge may be moulded into the vessel wall, then the sensor electrodes 2 fitted to the first wall or to the second wall of the sight glass which is then clipped or otherwise fastened into place. The film substrate of the sensor electrodes may be adhesive to assist its mounting into position and to ensure a consistent and reliable contact with the vessel wall.

In the above proposal the capacitive level sensor is not intended to give a continuous level indication, although this could be provided by the system at additional cost. A power supply would have to be provided whilst the kettle was disconnected from the mains, either by a battery or a capacitor, and a continuous display would be needed. It is much simpler just to provide a conventional sight glass and to use the function of the capacitive sensor in a protective role, in which case no power would be required until the kettle was switched on. The benefits of such a system are:

1. No heat at all would be applied if there was insufficient water - even less than with an electronic kettle which measures the rapid rate of rise associated with dry boil to give protection. Thus the stress on the heating element and on the arrangement of its sealing in the vessel would be removed.
2. If the kettle were allowed (or forced) to boil continuously, it would switch off before the heating element was exposed and allowed to overheat, again eliminating a source of stress on the element and seal.
3. By preventing use of the kettle when overfilled the risk of scalding from splashing boiling water is removed. This facility is not available on any currently manufactured kettle, nor has ever been as far as we are aware. If the kettle uses a conventional steam actuated boil control, then the risk of water splashing over into the control via the steam duct is also much reduced.

The invention having been described in the foregoing by reference to a specific embodiment, it is to be appreciated that the embodiment is in all respects exemplary and that modifications and variations could be made without departure from the scope of the invention. For example, the back-up protector 11 in the described arrangement and/or the boil control 10 could be

constituted by appropriate electronic arrangements as indeed could the control device 6.

CLAIMS:

1. An electrically heated liquid heating appliance including a capacitive liquid level sensor arranged to disable the supply of electricity to the appliance heating element if there is insufficient liquid in the appliance.
2. An appliance as claimed in claim 1 including a liquid level sensor arranged to disable the supply of electricity to the appliance heating element if there is an excessive amount of liquid in the appliance.
3. An appliance as claimed in claim 1 including a capacitive liquid level sensor arranged to disable the supply of electricity to the appliance heating element if there is an excessive amount of liquid in the appliance.
4. An appliance as claimed in claims 1 and 3 wherein a single capacitive sensor coupled to a control device is arranged to be responsive to there being insufficient liquid in the appliance and to there being an excessive amount of liquid in the appliance.
5. An appliance as claimed in claim 4 wherein said control device is arranged to provide an indication on occurrence of the detection of insufficient or excessive amounts of liquid in the appliance.

6. An appliance as claimed in claim 4 or 5 wherein said control device is arranged to operate switch means in circuit with the appliance heating element, there being additionally in circuit with the heating element a switch
5 means which is operable by a heating element overtemperature responsive device and/or a switch means which is operable by a device responsive to boiling of liquid in the appliance.

7. An appliance as claimed in any of the preceding claims wherein said
10 capacitive sensor includes a pair of parallel conductors.

8. An appliance as claimed in claim 7 wherein said conductors are provided in a sandwiched configuration incorporated into a wall portion of the
15 appliance.

9. An appliance as claimed in claim 8 wherein said wall portion is a sight
glass of the appliance.

10. A liquid heating appliance substantially as herein described with
20 reference to the accompanying drawing.



Application No: GB 0002783.9
Claims searched: 1-10

Examiner: David Harness
Date of search: 18 May 2000

Patents Act 1977 Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.R): A4A (AB2, APL, APK)

Int Cl (Ed.7): A47J 27/21; G01F 23/26

Other: Online: WPI, EPODOC, JAPIO

Documents considered to be relevant:

| Category | Identity of document and relevant passage | Relevant to claims |
|----------|---|--------------------|
| Y | US 5756876 (WETZEL ET AL) See figure 2 and line 67, column 2, to line 6, column 3. | 1-3 |
| Y | US 5671113 (KNEPLER) See figure 1 and lines 34-36 column 4. | 1-3 |
| A | US 4544830 (MILLER) See figure 2 | |

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|---|---|---|--|
| X | Document indicating lack of novelty or inventive step | A | Document indicating technological background and/or state of the art. |
| Y | Document indicating lack of inventive step if combined with one or more other documents of same category. | P | Document published on or after the declared priority date but before the filing date of this invention. |
| & | Member of the same patent family | E | Patent document published on or after, but with priority date earlier than, the filing date of this application. |

Legal status (INPADOC) of **GB2358789**

GB F **0002783 A** (Patent of invention)
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